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XX. *A Letter to Martin Folkes, Esq; President of the Royal Society, from Cromwell Mortimer, M. D. Secr. of the same, concerning the natural Heat of Animals.*

S I R,

June 20. 1745.

*Read July 4.
1745.*

SINCE the complete and full Demonstration of the Circulation of the Blood in Animals by our illustrious Countryman the great Dr. *Harvey*, the Generality of medical Writers have attributed the natural Heat of Animals to the Motion of the Blood in the Blood-vessels, or rather to an Attrition of all the Fluids in the Animal arising from it; which Fluids, from the later Discoveries by Injections and Microscopes, are found to move in conical Canals communicating one with another near the *Apices*, or where the Arteries are the narrowest, soon afterwards growing wider and wider, when the same continued Canals obtain the Name of Veins, and convey back the Fluids they contain to the Heart. They ascribe Heat in an Animal to strong and frequent Contractions of the Heart and Arteries; which Heat * will be the greater, the more dense the Humours are, the more strongly they are propell'd, and the greater the Resistances are, near the Ends of the Arteries. From this Supposition they conclude, that the Heat arises from Attrition; that, by a violent Agitation of the Particles of the Blood and Humours against one another, and especially by the Attrition of them against the Sides of the containing Blood-vessels,,

* *Boerhaave Instit. §. 968.*

vessels, there must be great Friction excited, and from that Friction Heat generated; as is easily done by rubbing two Pieces of Wood together, or a Piece of Wood and a Piece of Metal, or two Pieces of Metal, or hard Stones: but it is known, by daily Experience, that either any watery Fluid, or oily or greasy Substance, applied to these Bodies while rubbed, will prevent the Excitation of Heat; as for Instance, the Use of Water in polishing of Glass or Marble, and the greasing or oiling all manner of Wheel-Machines, many of which, for want of that Application, have heated, taken Fire, and been even consumed in Flames of their own exciting. I know of no Experiment, whereby it appears, that any the least Degree of Heat has been generated by the simple or mere mechanical Agitation or Friction of the Particles of any Fluid, either by itself, or mixed with various Fluids; Water, Wine, vinous Spirits, Oils, Quick-silver, either agitated singly or mixed, will by no Force, or Velocity of Motion I ever heard of, produce Heat; nor can the Blood of Animals, when once let out of the Body, be kept either fluid or warm by any the most violent Agitation. Indeed Heat is generated in Fluids in some particular Circumstances, as in those two so commonly known Cases of *Fermentation* and *Effervescence*; which, as they are frequently confounded by Persons not thoroughly versed in chemical Matters, I shall beg Leave to explain the Difference. *Fermentation* is that spontaneous intestine Motion, which, in the Degree of Heat of the universal Temperature of subterraneous Caverns, will, in a few Hours, bring on such a Change in vegetable Juices, or in Water charged with

with a strong Tincture of vegetable Particles (for Fermentation is confined to the Vegetable Kingdom solely) as from a vapid Must or Wort quenching Fire, to make it become more or less inflammable and nourishing of Fire, as it is impregnated with more or fewer of the vegetable Particles, and in the Alembic to afford that volatile subtil inflammable Liquor commonly called vinous Spirits. The Heat produced by Fermentation never exceeds that of the human Body. *Effervescence* arises from an intestine Motion, to be excited in various Sorts of Fluids, either by the Mixture of Fluids with Fluids of different Natures together, or by dropping in Salts or Powders of different Natures into different Fluids: The two most common Opposites, *Acids* and *Alcali's*, on being mixt, cause a great Ebullition or Frothing, but no great Heat; but the Solutions of some Metals in *Aqua fortis* cause intense Heat, and emit Flame: The mixing aromatic Oils with acid mineral Spirits actually kindle, and burn with violent Explosions; and some vegetable Substances, putrefying with Moisture, will sometimes heat so, as to kindle what lies dry above that Part of the Heap where the Putrefaction happens. Thus Dung-Heaps will heat, and Haycocks often kindle into actual Fire.

In these Cases of Effervescence, as there is no adventitious Heat or Fire applied, there must be the Elements of Fire lying hid or dormant in one or other of the Bodies; and it is sufficiently known, by Experiment, that there is Abundance of Air lies dormant in all Bodies both solid and fluid; and it is likewise known, that Fire cannot exert itself without the elastic Assistance of common Air; for Wood
will

will not burn, nor even Gunpowder fire, in the artificial *Vacuum*. It being therefore granted, that there are the Elements of Fire and of Air lying dormant in all Bodies; there is only required such an Action as may set at Liberty the Particles of Air, and the Particles of Fire; by which Action the Particles of Air will recover their Elasticity, and, putting the Particles of Fire in Motion, cause Heat or Warmth, but not Incension or Inflammation; unless the Fire thus agitated meets with a proper *Pabulum*, which *Pabulum* is *Sulphur* only, tho' differently modified, whether under the Appearance of Brimstone, *Bitumen*, Oil, vinous Spirits, vegetable Substances when deprived of their Water, metalline Sulphurs, or the most inflammable of all, animal Sulphur, commonly called by our modern Chemists *Phosphorus*.

Thus in Fermentation, the Fire and Air being let loose, produce a Warmth, but do not kindle, because of the Water predominating; whereas in the Effervescence produced by the Solution of Metals, the Fire meets with the metalline Sulphur, which it kindles, and sometimes causes Explosions; the aromatic Oils containing but little Water, being almost entirely composed of the sulphureous Parts of the Vegetables, immediately kindle, and break out into Flame; and *Phosphorus*, which is nothing but the animal Sulphur, as appears by the curious Account of it given us by that late ingenious Chemist Mr. *Godfrey*, a worthy Member of this *Society*, (*see* *Trans.* N^o. 428. p. 69. 70. is so greatly disposed to take Fire, that if it be only exposed a few Minutes to the open Air, it kindles and flames.

Now all Animals, on which Experiments have been made, are found to contain more or less of the phosphoreal Principles; some Insects constantly shine, or emit Light, in the open Air; many Sorts of Fish are luminous, if exposed to the Air a short time; nay even the Bubbles of the Sea-water appear like Fire in the Dark: some Quadrupeds have been observed to emit Light on very slight Friction of their Hair, as the Necks of Horses, the Backs of Cats, and the like; and there are many Instances in our own Species, of many Parts of the Body appearing luminous, and even of the Exhalations from it adhering to the Cloaths, causing them to shine likewise; of which several curious Observations* have lately been laid before this *Society*: These, I think, are convincing Proofs of *Phosphorus* existing, at least in a dormant State, in animal Fluids; and as it is likewise certain, that they all contain Air, it is only necessary to bring the phosphoreal and æreal Particles to Contact, and Heat must of consequence be generated; and was it not for the Superabundance of aqueous Humours in Animals, I do not doubt, but fatal Incensions would frequently happen. This, I think, explains evidently the Cause of animal Heat: Indeed the Heart and Arteries are the Instruments which excite this Heat; but that is not done by the Friction caused by the Circulation of the Humours, but only by the intestine Motion, which the Circulation gives to the several Particles which constitute the Mass of animal Fluids; and as the Velocity of these Fluids is increased, so must the different Particles, of which they consist, come
oftener

* See above in this *Transf.* p. 444. 445. 456. 457. &c.

oftener into Contact; and, consequently, the oftener the phosphoreal and the aëreal meet, the more frequent and greater must the *Nifus's* be to create Heat.

Hippocrates (*Aph.* I. 14.) mentions the *Θέρμον ἐμφύλον*, *Calidum innatum*. *Galen* takes it for the *Soul*, and more modern Writers have supposed it to be the very *Spirit*, the *Archeus*, and others the *Vital Heat*; but have all treated of it as a certain Degree of Fire existing in Animals; not having any Notion, that the Element of Fire might be absorbed, or lie latent, in fluid Bodies, ready to become active as soon as it meets with Air, or even to kindle, if it meets with sulphureous Particles under proper Circumstances. This I fancy the Antients, in the very earliest Ages of the World, had some Notions of; when they thought proper to communicate to the Vulgar some Shadows only of more profound and real Knowledge under Types and Fables, as handed down to us in the Fictions of the Poets: Of this kind, and quite to our Purpose, I take the Fiction of *Prometheus* stealing Fire from Heaven to animate his Men with, to be one. And, I think, upon this Principle of *Phosphorus* existing in Animals, one may easily explain the Cause of those melancholy Accidents which have happened to some of the human Species, as that of the Lady at *Cesena* in *Italy*, (a) the Carpenter in *Hampshire*, (b) and the Woman lately at *Ipswich* (c); who, it is most probable, were all set on Fire by Lightening: It may be said, Many are struck by Lightening, but not set on Fire; but it is to be remarked, that the Lady at *Cesena* had charged all her Pores and absorbent Vessels with a great Quantity

(a) See this *Transf.* p. 447. (b) *Ib.* p. 461. (c) *Ib.* p. 463.

tity of Camphire ; the Woman at *Ipswich* had drank Plenty of Gin ; and as for the Carpenter, that Circumstance is not recorded of him, whether he was an hard Drinker or not ; which Circumstances must greatly promote the kindling the phosphoreal Fire in them ; and, as this *Pabulum* was conveyed into the most minute capillary Vessels, might produce an almost instantaneous Deflagration and Dissolution of all the solid containing Parts.

Animals appearing more susceptible of electric Fire than other Bodies, greatly confirms my Conjectures of the phosphoreal Principles ; and I should think, that being render'd electric to any high Degree might prove a dangerous Experiment to a Person habituated to a plentiful Use of spirituous Liquors, or to Embrocations with camphorated Spirit of Wine ; on the contrary, in some languid, cold, or worn-out Constitutions, possibly, future Experiments may evince, that Electricity may be used medically, in order to renew and regenerate a proper Quantity of vital Fire, such as is necessary for the conveniently carrying on, and performing the animal Functions.

I hope, Sir, your Goodness will excuse the Haste with which I have penned down these Thoughts, being the Subject of a Letter I wrote to my much respected Preceptor the famous *Boerhaave* *, while I was at *Leyden* above 20 Years ago ; but which not finding

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* Who honoured me with an intimate literary Correspondence even to within a few Days of his Death ; it being to me, *Amico Londinensi*, a Friend at *London*, that he wrote that Letter stating his own Case, as published by *Prof. Schnleus* in his Oration on *Boerhaave's* Death, p. 69. but why that Gentleman suppressed my Name I know not.

a Copy of, and he only telling me, it was a pretty *Hypothesis*, I never reflected upon since, till these electrical Experiments lately read before the *Society*, and those Accounts of luminous Emanations from human Bodies, had brought them back to my Mind; and I think I have now set them a little beyond a mere *Hypothesis*. I am,

S I R,

Your most obliged,

Devoted, humble Servant,

Cromwell Mortimer.

July 4. 1745. the SOCIETY adjourned to Oct. 24.

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N. B. A Letter from Dr. *Miles* to Mr. *Baker* having been published in the *Phil. Transf.* N°. 469. as that Gentleman has nothing in View but the Discovery of Truth, he thinks proper to rectify a Mistake he then made, in supposing certain Bodies to have been animal Substances, from their seeming to have a spontaneous Motion in Water: it having since appeared to him that they were only the Seeds of the *Bidens foliis tripartitè divis. Cæsalp.* 488. TOURNEFORT. p. 462. *Tab.* 262. that had fallen into the Water, and were possibly possess'd by some Insects which might give them that Motion.

E R R A T A.

In *Transaction* 475. pag. 285. l. 24. for *Calender*, read *Calendar*:
ib. p. 286. l. 1. for D, G, N and O, read G, D, N, and O.

In *Page* 373. *Line* 23. of this *Transaction* for *Snonebergam* read *Sonnebergam*: *Ib.* p. 393. l. 1. for Mr. read Dr. *Bamber*: *Ibid.* p. 457. l. 19. for *Act. Med. Phil. & Hafn.* read *Acta Med. & Philos. Hafnienf.*